EXPERT PORTRAIT

Marie LABAT,
Researcher in the Diagnostics Group

Marie in the Diagnostics laboratory, at SOLEIL.

Whether they are lasers or synchrotrons, light sources are at the heart of Marie's research. And since her thesis, one of these sources has been SOLEIL.

What path led you to SOLEIL?

When I began my engineering studies at the Ecole Centrale, the physics program left me hungry for more. So I decided to follow evening classes for the Master in Fundamental Physics offered by the University of Paris Sud on the Orsay campus. This Master then led to a DEA in large-scale facilities in my final year. In 2005, I started a thesis on free electron lasers (FEL) supervised by Marie-Emmanuelle Couprie, who was at the CEA at that time. The experimental part of my thesis work was taking place both on the UVSOR synchrotron in Japan and on the SPARC FEL project in Italy. Then Marie-Emmanuelle went to work at SOLEIL, where I joined her in 2007 for the final year of my thesis. Since I was based at SOLEIL, I gradually got involved in the Diagnostics Group activities of the Source Division at SOLEIL, essentially by helping in the installation of a streak camera for electron bunch length measurements on the storage ring. At the end of my thesis, the experimental module that I had made for the SPARC project had still not been installed. It was waiting quietly in a crate for the accelerator to be finished: the delay was more than a year for various reasons. To finish what I had started, I went for a one-year post-doc to Frascati, Italy. I then had the chance to get involved in the commissioning of the SPARC FEL. But after the first year, my module was still not installed. In view of the accumulated delays and weary of battle, I decided to leave the project and search for a new post-doc position, preferably in France. As luck would have it, a position came up at SOLEIL in the Diagnostics Group, led at this time by Jean-Claude Denard. I had very little experience in this area, but the Diagnostics Group just happened to be looking for a physicist/engineer to work on new generation light sources: a godsend. So I joined SOLEIL in 2010.

What does your work involve?

The aim of the Diagnostics Group is to characterize the electron beam in the LINAC and storage ring at SOLEIL. The group consists of six people, each with their own specialty. Mine is optical diagnostics, i.e. diagnostics using the radiation produced by electrons to measure their properties, and not the electrons directly, as in the case of electronic diagnostics. It is both the work of an engineer and a researcher, which I particularly like.
I am also involved in the femto-slicing project (see Rayon de SOLEIL No. 24, p 20) the goal of which is to provide femtosecond X-ray pulses to several SOLEIL beamlines, for the study of ultrafast phenomena. I set up the diagnostics for the «machine» part of the project and I am currently participating in its commissionning. Again, I find myself at the interface between physics and engineering.
Furthermore, I am also carrying out more «research» based work focused on the [1]LUNEX5 project, led by M.E. Couprie. This is an original fourth and fifth generation source project. The purpose is to

provide high brilliance sub-picosecond pulses in the soft X-ray region with an FEL powered by a conventional radio frequency accelerator (LINAC), and to set up the first FEL powered by a plasma accelerator. Two years ago, an ERC grant enabled us to launch the COXINEL1 program, which should enable us to create a plasma accelerator based FEL prototype at the Laboratoire d'Optique Appliquée (LOA). Initial experiments are programmed for early 2016. My work for [1]LUNEX5 is essentially carrying out simulations of radiation generation. However, on [2]COXINEL, I am also in charge of setting up photon diagnostics. My colleagues in the group are responsible for setting up electron diagnostics.
This research topic is in some ways an extension of my thesis, the theoretical part encompassing the 4th generation light source project «Arc-en-Ciel», which never saw the light of day. Synchrotrons and FELs are complementary; operational FELs are currently being inundated with requests from users, so it is essential that France acquires such equipment.

At SOLEIL, I thus have the opportunity to immerse myself in the «very theoretical» but also to do something practical by installing equipment that I designed. This is exactly what I look for in my work.

How is your work going on slicing?

The project started in 2012. By 2013 we had installed most of the equipment, and in 2014 the laser has been transported to the interaction point in the storage ring. In September 2014, we obtained the first laser-electron interaction and we are now commissioning the CRISTAL beamline. Also, an important step was taken recently: on October 5th, the first sliced X-ray beam from the laser was recorded by the detector located in the CRISTAL optics hutch, the first SOLEIL beamline to use slicing!
Commissioning has also started gently on the TEMPO beamline, another beamline using slicing, but this one is more complex for the moment. Indeed, on CRISTAL, only the diaphragm had to be modified to capture the radiation emitted by the classical off-axis sliced bunches. In the case of TEMPO, changes are required further upstream, adding magnets in the ring to help sliced bunches to acquire the appropriate axis to enter the front-end. First tests have been carried out, leading to improved diagnostic tools. We will hopefully get the first sliced beams in early 2016.

And what about monitors for the storage ring?

My work focuses on two main types of equipment: XBPMs (X-ray beam position monitors) and pinhole cameras (PHC). The former consist of metal blades sensitive to X-rays, placed right at the beginning of the beamlines (still in the ring tunnel). The blades are used to detect the position of the radiation emitted by the dipoles and undulators at the front-ends. They thus provide additional indirect information on the position and angle of the electron bunches at the source of the storage ring. The ring was already equipped with several XBPMs when I arrived. But I then took over from Jean-Claude Denard, to design and install new XBPMs with Nicolas Hubert. In particular, we have developed a special double XBPM for the Nanoscopium and ANATOMIX beamlines. Because of the existing angle between their respective undulators, the synchrotron radiation is in fact divided into two when it arrives at their common front-end. It was therefore necessary to design a «two-headed» XBPM.
As for pinhole cameras, these give a measure of the transverse dimensions of the beam through constantly measuring the X-rays produced by the electrons. If there are two such devices, it is also possible to measure the dispersion, which is an important parameter of the machine. Up to now only one pinhole camera is in operation; we plan to install a second one at the beginning of 2016.

What highlights will you remember from those years at SOLEIL?

Obtaining the first sliced beams in the ring remains a special moment as we had been waiting for months and for which we had slaved extremely hard for almost two years. The beginning of my maternity leave was fast approaching: it was essential that it work before I left, as I really wanted to be present and not miss that moment! In September 29, 2014, we were all eyeing the screen of the oscilloscope, to scan the signal from the bolometer which would prove to us that there was some interaction between the «slicing» laser and the electron bunch. When the signal finally appeared, a great cry of joy rang out, followed by huge relief. The «bolo» was in the spotlight. So much so that my colleagues jokingly suggested that I should name my future child «Bolo». I have just kept the «o» sound!

→ **Contact:**
marie.labat@synchrotron-soleil.fr

[1]LUNEX5: free electron Laser Using a New accelerator for the Exploitation of X-ray radiation of 5th generation

[2]COXINEL: COherent Xray source INferred from Electrons accelerated by Laser